

MECHANICAL ENGINEERING CAPSTONE



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Mechanical Engineering Capstone

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Licensing

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Chapter 1: CV/Resume

How to Write a CV/Resume for Mechanical Engineers

General Tips

1. **Keep It Concise:** A resume should be 1-2 pages for early-career engineers. Use bullet points and concise language to convey your experience.
2. **Tailor for the Role:** Customize your resume for each application by emphasizing relevant skills and experiences aligned with the job description.
3. **Use Professional Formatting:**
 - Clear headings (e.g., Education, Skills, Experience, Projects).
 - Consistent font (e.g., Arial, Times New Roman, or Calibri).
 - Use bold or italics sparingly to highlight key points.
4. **Prioritize Content:** List experiences in reverse chronological order, starting with the most recent.

Essential Sections

1. Contact Information

- Full Name
- Professional Email Address (e.g., first.last@email.com)
- Phone Number
- LinkedIn Profile (optional but recommended)
- Portfolio or GitHub Link (if applicable)

2. Career Objective or Summary (Optional)

- A brief (2-3 sentences) statement about your career goals, technical expertise, and what you bring to the table.

Example:

"Mechanical Engineering graduate with hands-on experience in [Capstone Project]. Skilled in [list relevant skills] with a strong background in [specific areas like CAD modeling, FEA analysis, or materials testing]. Seeking a position in [specific field or type of company] to apply problem-solving and design expertise."

3. Education

- Degree: *Bachelor of Science in Mechanical Engineering*
- Institution: [University Name]
- Graduation Date: [Month, Year]
- GPA (optional if >3.0)
- Relevant Coursework (optional): Include advanced or specialized courses that align with your career goals.

4. Skills

- Divide into **Technical Skills** and **Soft Skills**:

Technical Skills: Proficiency in CAD software (e.g., SolidWorks, AutoCAD), FEA tools (e.g., ANSYS), MATLAB, Python, or lab equipment.

Soft Skills: Leadership, teamwork, problem-solving, communication.

- Highlight certifications (e.g., Lean Six Sigma, EIT certification).

5. Capstone Project Experience

- **Project Title:** Be specific and descriptive (e.g., "Design and Fabrication of a Tungsten Carbide Band Breaker for Medical Applications").
- **Objective:** What problem were you solving? What was the goal?
- **Key Contributions:** List your role and major achievements. Use action verbs (e.g., "Designed," "Simulated," "Led," "Fabricated").
- **Technical Skills Applied:** Mention software, tools, or methodologies used.

- **Outcomes:** Highlight the results, such as prototypes created, cost savings, or client satisfaction.

Example:

Capstone Project: Medical Device for Tungsten Carbide Band Removal

- Designed and fabricated a device to safely break tungsten carbide rings, addressing thermal necrosis risks in collaboration with surgeons.
 - Conducted finite element analysis (FEA) to optimize the design for durability and safety.
 - Successfully delivered a functional prototype, leading to client approval and adoption for further testing.
6. Professional Experience (if applicable)
- Include internships, co-ops, research assistantships, or part-time engineering roles.
 - Use bullet points to describe achievements and responsibilities, focusing on measurable outcomes (e.g., "Reduced manufacturing time by 15% by implementing [specific improvement]").
7. Additional Projects (Optional)
- Include personal, academic, or extracurricular projects demonstrating technical or leadership skills.
8. Leadership and Activities
- Mention participation in engineering societies (e.g., ASME, SAE).
 - Highlight leadership roles (e.g., "President, Engineering Club") and team collaborations.
9. Awards and Honors
- Scholarships, competitions, or recognition related to engineering.
10. References
- Optional: "Available upon request" is sufficient unless specifically asked to list references.
-

Example Resume Layout

[Full Name]

[Address] | [Email Address] | [Phone Number] | [LinkedIn Profile] | [Portfolio/GitHub Link]

Objective

[Insert brief objective statement]

Education

Bachelor of Science in Mechanical Engineering

[University Name], [City, State]

Graduation: [Month, Year] | GPA: [if >3.0]

Skills

Technical Skills: [List technical proficiencies]

Soft Skills: [List interpersonal skills]

Capstone Project

Project Title

[Brief description of the project, role, and outcomes]

Professional Experience

Job Title, [Company Name], [Location]

[Month, Year] – [Month, Year]

- [Responsibility/achievement bullet point]
- [Responsibility/achievement bullet point]

Leadership and Activities

- [Role, Organization, Duration]

- [Role, Organization, Duration]

Awards and Honors

- [Award Name], [Year]

References

Available upon request

Or you can use a format similar to the one seen here

Name, Address, Email, Phone, LinkedIn
Education: School, Degree, GPA, Major, Minor, Thesis
Industry Experience: Include Company, Project, Key Details, Tailor to Job Application
Research Experience: Include Advisor/group, Website, Accomplishments
Clubs: Include Position, Accomplishments, Links to Club Activities
Teaching Experience: ISA Positions, include classes, etc
Awards, Skills, Certifications, Personal

Figure *Chapter1.1*: CV/Resume Layout Example

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Chapter 2: LinkedIn

Creating a Strong LinkedIn Profile for Mechanical Engineers

LinkedIn is an essential tool for professional networking, job searching, and showcasing your skills and projects as a mechanical engineer. Here's a step-by-step guide to build a compelling profile, with encouragement to join the Cal Poly Humboldt Mechanical Engineering LinkedIn group for networking opportunities.

1. Build a Complete and Professional Profile

a. Use a Professional Photo

- Choose a clear, professional headshot with a neutral background. Dress in business casual or attire appropriate for engineering roles.

b. Craft a Compelling Headline

- Include your role and aspirations. For example:
"Mechanical Engineering Senior | Specializing in CAD Design and Thermal Analysis | Capstone Innovator"

c. Write an Engaging Summary

- Use the first-person perspective to describe:
 - Your career goals and engineering passions.
 - Key skills (e.g., SolidWorks, FEA, materials testing).
 - Capstone or significant projects.
 - A call to action (e.g., "I'm excited to connect with professionals in mechanical design and manufacturing.")

Example Summary:

"As a senior mechanical engineering student at Cal Poly Humboldt, I am passionate about solving complex problems through innovative design and analysis. My capstone project, focused on developing a medical device to address thermal necrosis risks, reflects my commitment to impactful engineering solutions. Proficient in SolidWorks, ANSYS, and MATLAB, I aim to contribute to a team where I can apply and grow my technical and leadership skills. Let's connect to discuss opportunities in design, simulation, and manufacturing."

d. Customize Your URL

- Edit your LinkedIn URL to include your name for a clean, professional look (e.g., [linkedin.com/in/YourName](https://www.linkedin.com/in/YourName)).

2. Highlight Your Education and Skills

a. Education Section

- List your degree: *Bachelor of Science in Mechanical Engineering*
- Include relevant coursework, academic honors, and projects.

b. Skills Section

- Add technical skills (e.g., "Finite Element Analysis," "3D Printing," "MATLAB").
- Include soft skills (e.g., "Team Leadership," "Project Management").

c. Certifications

- Include EIT Certification, Lean Six Sigma, or relevant software certifications.

3. Showcase Your Capstone and Projects

a. Create a Project Section

- Add your capstone project with a clear description of the problem, your role, and the outcome.
- Upload supporting materials, like CAD models, technical reports, or photos (if appropriate and non-confidential).

b. Feature Content

- Use the Featured section to highlight publications, presentations, or links to GitHub/portfolios.
-

4. Build a Strong Network

a. Connect Thoughtfully

- Send personalized connection requests, especially to alumni, professors, and industry professionals.

b. Join Relevant Groups

- **Cal Poly Humboldt Mechanical Engineering Group:** Joining this group allows you to network with peers, alumni, and industry contacts.
 - Benefits include job postings, mentorship opportunities, and discussions on industry trends.
 - How to Join: Search for *Cal Poly Humboldt Mechanical Engineering* in LinkedIn groups and request to join.

c. Follow Influential Companies and Organizations

- Follow mechanical engineering firms, professional societies like ASME, and relevant thought leaders to stay updated.
-

5. Be Active and Engaged

a. Post Updates

- Share milestones, like completing your capstone project, attending conferences, or earning certifications.
- Add visuals when possible (e.g., project images, diagrams).

b. Comment and Interact

- Engage with posts by alumni, classmates, and group members to build visibility and connections.

c. Request Recommendations

- Politely ask professors, supervisors, or peers to write recommendations highlighting your strengths.
-

Encouraging Students to Join the Cal Poly Humboldt Group

- **"Expand Your Network":** By joining the Cal Poly Humboldt Mechanical Engineering group, you'll connect with alumni and professionals who can offer mentorship, share job opportunities, and provide industry insights.
 - **"Showcase Your Work":** The group is a great place to share your capstone progress, seek advice, and gain visibility within the community.
 - **"Find Opportunities":** Members frequently share internships, job openings, and events tailored for Humboldt engineering students and graduates.
 - **"Support Your Career":** By staying active in the group, you can build a long-term professional network that supports your career growth.
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Chapter 3: Team Contract Agreement

How to Create a Group/Team Contract Agreement for Mechanical Engineering Capstone Students

A group or team contract is an essential document for capstone projects. It sets clear expectations, defines roles, and ensures accountability among team members. Here's how to create an effective team contract.

1. Purpose of the Contract

Explain why the contract exists and its importance in fostering collaboration and accountability.

Example:

“This team contract is designed to establish shared goals, roles, and expectations to ensure a productive, respectful, and successful collaboration on our capstone project.”

2. Key Sections to Include

a. Team Information

- List all team members with contact information (names, emails, phone numbers).
- Include your team name (if applicable).

b. Project Goals and Objectives

- Clearly state the project's purpose, scope, and deliverables.
- Example:
“Our goal is to design and fabricate a device to safely remove tungsten carbide rings, ensuring client requirements are met and the final product is ready for testing by [deadline].”

c. Team Roles and Responsibilities

- Assign specific roles based on skills and interests (e.g., project manager, CAD designer, materials researcher, testing coordinator).
- Define the responsibilities for each role.

Example:

- **Project Manager:** Oversees timeline and deliverables, organizes meetings, communicates with advisors.
- **CAD Designer:** Develops 3D models and ensures design accuracy.
- **Testing Coordinator:** Plans and executes experimental tests, documents results.

d. Meeting Schedule and Communication Plan

- Decide on regular meeting times (e.g., weekly on Mondays at 5:00 PM).
- Define communication channels (e.g., Slack, email, Zoom).
- Establish response time expectations (e.g., respond to messages within 24 hours).

e. Workload and Deadlines

- Agree on how tasks will be divided and tracked. Use tools like Gantt charts or project management software (e.g., Trello, Asana).
- Include consequences for missed deadlines (e.g., redistribution of tasks, team discussion).

f. Conflict Resolution Plan

- Outline how the team will handle disagreements.
- Example:
 - Address issues directly and respectfully during a team meeting.
 - If unresolved, escalate to the faculty advisor for mediation.

g. Attendance and Participation

- Specify attendance requirements for meetings and project work.
- Include expectations for participation and engagement.

- Example:
“Each team member is expected to attend at least 90% of team meetings unless prior notice is given.”

h. Code of Conduct

- Define behaviors that support a respectful and collaborative environment.
- Example:
 - Be respectful and listen to all ideas.
 - Commit to resolving conflicts constructively.
 - Avoid unprofessional language or behaviors.

i. Accountability and Consequences

- State the process for holding members accountable.
- Example:
 - Document recurring issues and discuss them during meetings.
 - Report severe or unresolved issues to the advisor.

j. Amendments

- Allow room for revisions if necessary.
- Example:
“This contract may be amended if all members agree to the changes in writing.”

k. Signatures

- Include a section where all team members sign and date the contract to confirm agreement.

3. Best Practices for Implementing the Contract

- **Collaborate on Creation:** Develop the contract as a team to ensure buy-in from all members.
- **Review Regularly:** Revisit the contract periodically to ensure expectations are being met.
- **Keep It Accessible:** Store a copy in a shared folder or platform for easy reference.

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Chapter 4: 3 Slide Check-In

Guidelines for Preparing a 3-Slide Weekly Check-In for Mechanical Engineering Capstone Projects

The purpose of a 3-slide check-in is to maintain project momentum, provide updates to your advisors or stakeholders, and receive feedback. Below are detailed instructions on creating and presenting these slides.

Slide 1: Recap of the Plan from Last Week

Purpose: Show how you planned to progress since the last check-in.

Content Suggestions:

- **Title:** "Recap of Last Week's Plan"
- **Key Elements to Include:**
 - Objectives or milestones planned for last week.
 - Tasks assigned to each team member.
 - Specific deliverables or outputs expected.
- **Visuals:**
 - Gantt chart snippet showing progress and schedule.
 - Diagram of the workflow or planned system.
 - Photos/screenshots of designs, CAD models, or schematics from the planning phase.

Notes Section:

- Provide a detailed description of each point in bullet form.
- Mention who was responsible for each task and whether it was on track.

Primary Contact for This Slide:

- Indicate which team member is responsible for the plan and will answer questions related to this slide.
-

Slide 2: Work Done This Week and Results

Purpose: Highlight the team's accomplishments and show tangible progress or results.

Content Suggestions:

- **Title:** "Work Completed and Results This Week"
- **Key Elements to Include:**
 - Summary of tasks accomplished (e.g., designs finalized, prototypes built, tests conducted).
 - Quantifiable results or progress (e.g., test data, calculations, or simulations).
 - Challenges encountered and how they were addressed.
- **Visuals:**
 - High-quality images or videos of prototypes, experiments, or models.
 - Graphs or charts summarizing data.
 - Screenshots of simulation results, CAD renders, or FEA outputs.

Notes Section:

- Provide additional context and technical details for each result.
- Explain any challenges, how they were resolved, and any deviations from the plan.

Primary Contact for This Slide:

- Specify who led the work presented and will address related questions.
-

Slide 3: Preliminary Plan for Next Week

Purpose: Present a roadmap for the upcoming week, highlighting priorities and deliverables.

Content Suggestions:

- **Title:** "Plan for Next Week"
- **Key Elements to Include:**
 - High-level goals for the coming week.
 - Specific tasks for each team member.
 - Deadlines or milestones.
 - Any resources, materials, or assistance needed.
- **Visuals:**
 - Updated Gantt chart or timeline showing next steps.
 - Annotated design iterations or schematics of planned work.
 - Flowchart outlining the next stages of the process.

Notes Section:

- Elaborate on the specific steps for each task.
- Mention potential risks and contingency plans.
- List any questions or decisions that require feedback from advisors or stakeholders.

Primary Contact for This Slide:

- Identify the team member responsible for coordinating the next week's tasks.

General Presentation Tips

1. Slide Design:

- Keep slides visually appealing and uncluttered.
- Use bullet points and limit text on the slides themselves.
- Ensure all visuals are relevant, labeled, and clear.

2. Notes Section Usage:

- Treat the notes section as an extended narrative or script.
- Provide detailed explanations and technical information that may not fit on the slide.
- Anticipate possible questions and address them in the notes.

3. Presentation Delivery:

- Practice as a team to ensure a smooth flow.
- Each team member should be prepared to present their assigned slide.
- Be concise but thorough in your explanations.

4. Be Prepared for Discussion:

- Anticipate technical and logistical questions about your progress and plan.
- Have backup data or additional visuals ready in case they are requested.

5. Professionalism:

- Dress professionally or as required for the presentation setting.
- Ensure all team members are engaged and attentive during the discussion.

Checklist Before the Check-In

- ☐ Are all visuals (figures, schematics, videos) ready and clear?
- ☐ Are the notes sections filled with detailed explanations?
- ☐ Has each team member rehearsed their slide and is ready to discuss it?
- ☐ Is the contact person for each slide clearly indicated?

- ☐ Has the presentation been proofread for typos and clarity?

By following these guidelines, your team will deliver a polished and professional weekly check-in that highlights your progress and demonstrates your organization and teamwork.

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Chapter 5: GEARS Design Framework

The GEARS design framework is an effective structured approach for mechanical engineering capstone students to guide their projects from inception to validation. Below is a step-by-step explanation of the process:

1. Goals (G)

Focus: Define what success looks like for the project.

- **Deliverables:** Clearly outline what the team will deliver (e.g., a prototype, a design report, or a working model).
- **Functionality Requirements:** Identify what the system, device, or product must accomplish.
- **Design Specifications:** Establish precise requirements like dimensions, material properties, and operational conditions.
- **Key Performance Indicators (KPIs):** Specify measurable criteria (e.g., load capacity, efficiency, speed) that will be used to evaluate the project.

Implementation Steps:

1. Work with clients or stakeholders to clarify the desired outcomes.
 2. Document these goals in a project charter or design brief.
 3. Ensure all team members have a shared understanding of the objectives.
-

2. Engineering Specifications (E)

Focus: Translate project goals into precise technical requirements.

- Define critical dimensions, material tolerances, and environmental considerations.
- Ensure all specifications meet industry standards, regulatory requirements, and safety margins.

Implementation Steps:

1. Use tools like CAD software to develop detailed schematics.
 2. Identify tolerance limits for key components (e.g., ± 0.05 mm for a shaft diameter).
 3. Conduct a preliminary review to ensure specifications are realistic and achievable within the project constraints.
-

3. Analysis (A)

Focus: Evaluate the design to ensure reliability and safety.

- Assess the system against tolerance limits, KPIs, and safety margins.
- Identify risks, such as potential failure modes, and address them early.

Implementation Steps:

1. Perform engineering calculations, simulations, or finite element analysis (FEA) to evaluate stresses, deformations, and safety factors.
 2. Use risk assessment tools (e.g., Failure Mode and Effects Analysis - FMEA) to identify and mitigate risks.
 3. Document the analysis and align it with project goals and specifications.
-

4. Refinement (R)

Focus: Improve the design through prototyping, testing, and iteration.

- Develop and test physical or virtual prototypes to validate performance.
- Adjust the design as needed to meet goals, specifications, and KPIs.

Implementation Steps:

1. Fabricate a prototype or conduct simulations for testing.
2. Compare test results to KPIs and specifications.
3. Iterate the design based on testing feedback, focusing on improvements in safety, performance, and manufacturability.

4. Ensure proper documentation of changes for future reference.

5. Success Metrics (S)

Focus: Validate that the final product meets or exceeds expectations.

- Compare the performance of the final design against KPIs and client goals.
- Ensure compliance with all specifications and safety requirements.

Implementation Steps:

1. Conduct final testing and evaluations to verify the device's performance.
 2. Compile results into a final project report or presentation for stakeholders.
 3. Use feedback from clients and advisors to confirm project success.
-

Applying GEARS in a Capstone Team

- **Teamwork:** Assign team members to specific stages of GEARS based on their expertise (e.g., someone skilled in CAD for "Engineering Specifications" and another with simulation expertise for "Analysis").
- **Tools:** Use project management tools (e.g., Gantt charts, Trello) to track progress through the GEARS phases.
- **Documentation:** Maintain thorough records of decisions, designs, and test results throughout the process.

By following the GEARS framework, capstone students can systematically tackle complex engineering challenges, ensuring their designs are functional, safe, and aligned with client expectations.

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Chapter 6: Literature Review

Guidelines for Writing a Comprehensive Literature Review for Mechanical Engineering Capstone Students

A literature review is essential for understanding the current state of knowledge, identifying gaps, and grounding your capstone project in existing research and practices. Here's how to approach it effectively:

1. Define the Scope of Your Literature Review

Purpose:

- Clarify the topic, goals, and focus areas of your review.
- Determine the specific questions your review will address (e.g., "What are the current trends in additive manufacturing for lightweight structures?").

Steps:

1. Identify the key aspects of your project that require research (e.g., material properties, manufacturing methods, design optimization).
2. Discuss with your team and advisor to narrow down the focus areas.

2. Search for Relevant Sources

Purpose: Gather a wide range of high-quality, relevant literature to inform your review.

Steps:

1. Use reliable databases such as:
 - **Google Scholar**
 - **ASME Digital Collection**
 - **ScienceDirect**
2. Focus on peer-reviewed journal articles, conference papers, books, and credible technical reports.
3. Use relevant keywords (e.g., "finite element analysis of composites," "heat exchanger design optimization").
4. Track citations to find seminal papers in your field.

Tip: Utilize reference management tools like **Zotero**, **EndNote**, or **Mendeley** to organize your sources.

3. Analyze and Evaluate the Literature

Purpose: Understand the significance, methodology, and limitations of the literature to identify trends and gaps.

Steps:

1. Summarize each source, focusing on:
 - Research objectives.
 - Methods and approaches used (e.g., simulations, experiments).
 - Key findings and conclusions.
2. Evaluate the relevance of the research to your project.
3. Identify gaps or areas for improvement in existing research (e.g., limited data for specific operating conditions).

Tip: Create a matrix or table summarizing each source, including authors, methods, findings, and relevance.

4. Organize Your Literature Review

Purpose: Structure your review to flow logically and address your research objectives.

Possible Structures:

1. **Thematic Organization:**

- Group sources by topic or theme (e.g., material selection, manufacturing methods).

2. Methodological Organization:

- Group sources based on the type of approach (e.g., experimental studies, computational analyses).

3. Chronological Organization:

- Highlight how research has evolved over time.

Literature Review/Theoretical Background:

- Organized subsections focusing on themes, methods, or chronological trends.
 - Critically discuss the findings, gaps, and trends.
 - Summarize key insights.
 - Highlight how your capstone project builds on or addresses gaps in the literature.
-

5. Write Clearly and Concisely

Purpose: Ensure your review is easy to follow, professional, and well-supported by evidence.

Steps:

1. **Avoid Listing Sources:** Synthesize information by comparing and contrasting studies.
 - Example: “While Smith et al. [1] found that heat exchangers with wavy fins improved efficiency, Jones et al. [2] highlighted manufacturing challenges with such designs.”
 2. **Provide Context:** Relate the findings to your capstone project goals.
 3. **Use Proper Citations:** Follow the required citation style (e.g., IEEE, APA, or ASME).
-

6. Avoid Common Pitfalls

- **Irrelevance:** Only include sources directly related to your project.
 - **Plagiarism:** Always paraphrase and cite properly.
 - **Superficial Analysis:** Go beyond summarizing papers—critically evaluate their methodologies, strengths, and weaknesses.
-

7. Use Tools to Improve Quality

- **LaTeX:** For formatting complex reviews with equations and figures.
-

8. Seek Feedback

- Share drafts with your advisor or peers for feedback.
 - Revise based on comments to improve clarity and depth.
-

9. Link the Literature to Your Project

Purpose: Show how your project fits into the broader context of mechanical engineering research.

Steps:

1. Highlight where your project addresses gaps in the literature.
 2. Justify design decisions based on insights from the review.
-

10. Final Checklist Before Submission

- ☐ Does the review have a clear structure and focus?
- ☐ Are all sources properly cited and referenced?
- ☐ Is the connection between the literature and your project clear?
- ☐ Have you critically analyzed and synthesized the sources?

By following these steps, your literature review will serve as a strong foundation for your capstone project, demonstrating your ability to critically engage with existing research and make informed design decisions.

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